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Maternal depression symptoms are highly prevalent among Food insecure households of Ethiopia

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Ethical clearance

The study protocol was approved by institutional review boards from Addis Ababa University, College of Health Sciences. The study was also approved by the Regional Committee for Medical and Research Ethics, Western Norway (REK Vest). Information on the research objective was read to the participants and verbal informed consent was received. Privacy and confidentiality of respondents was also maintained.

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We declare that the funding body has no role in designing of the study, collection, analysis, and interpretation of data, writing of this manuscript and in the decision to submit for publication.

Competing interests

The authors declare that they have no competing interests.

Authors' contributions

SH and BL designed the study. SH, BL, BS, and CH participated in the data analysis and drafting of the manuscript. All authors read and approved the final manuscript.

Abstract

Objectives: We aimed to evaluate the association between household food insecurity and maternal depression in Ethiopia.

Methods: In 2014, we conducted a cross sectional study in southern Ethiopia, including 591 food secure and 2,500 food insecure households. We measured depression status of women using Patient Health Questionnaire validated for Ethiopia, with a cut-off of 5 and above. We evaluated the household-level food insecurity using a validated Household Food Insecurity Access Scale. We applied Bayesian modeling to evaluate the relationship between food insecurity and maternal depression accounting for other observed characteristics.

Result: Among the analytic sample, 80.9% [95% CI: 79.5, 82.2] of women were living in food insecure households. The overall prevalence of probable depression (mild and moderate forms) was 4.7 % [95% CI: 4.1, 5.6]. All of the individual depressive symptoms had a significantly higher prevalence in the food insecure group, except for suicidal ideation (but small numbers) ($p<0.001$). In the Bayesian model, adjusting for paternal characteristics, there was a significant dose response linear relationship (trend) between household food insecurity and maternal depression (*P<0.01*). The adjusted odds ratio (AOR) for depression for differing levels of food insecurity was as follows: mild food insecurity AOR 3.29; 95% [BCI]; 1.63–6.18, moderate AOR 3.82; 95% [BCI]; 1.91–7.45) and severe AOR 12.5; 95% [BCI]; 3.38–32.70).

Conclusion: This study documented a high burden of depression among women who lived in food insecure households. Given this finding, we recommend integrating mental health in the livelihood programs in areas suffering from food insecurity.

Introduction

Depressive disorders are one of the major public health problems globally. According to the 2015 Global Burden of Disease (GBD) study, depressive disorders are the 3rd leading cause of disability (1). A systematic review In low- and lower-middle-income countries showed about one in six pregnant women and one in five women who have recently given birth experienced common perinatal mental disorders (2). The aforementioned review revealed different determinants of common perinatal mental disorders such as financial difficulties, unemployment, difficulties in an intimate partner relationship, insufficient social support, and adverse reproductive outcomes. Furthermore, in developing countries a high prevalence of maternal CMD, ranging from 21% in Vietnam to 33% in Ethiopia is reported (3).

In Ethiopia, although there is no nationally representative data, maternal depression ranging from 5% to 37% was reported from different pocket studies (4-8). In a systematic review of 12 studies conducted from 1990 to 2012 in Ethiopia, the population prevalence of depression was estimated to be 11% (9).Female gender, marital loss, poor social support, low wealth index, tobacco smoking, hazardous use of alcohol, older age, having a co-morbid illness, and living alone, Stressful life events, increasing age were associated with CMD in Ethiopia(10, 11).

The World Food and Agricultural organization (FAO) in 2001 defined food security as: "*a situation that exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life*". According to the estimate made by FAO, 795 million people remain undernourished in 2015 (12). The estimate showed that East African countries had a bigger share the problem. In Ethiopia the prevalence of household food insecurity is estimated as high as 70%(13). Although Ethiopia has made significant progress against under nutrition, 40% of children in the country are stunted (14).

The health consequences of food insecurity go beyond under nutrition. There is accumulating evidence that shows a positive association between common mental

disorders (CMDs) and food insecurity (15-19). The association between depression and food insecurity is complex. A bidirectional causal relationship between household food insecurity and depression is documented (18). Food insecurity is indicated as a risk factor for depression. Different mechanisms such as psychological distress and micronutrient deficiency are reported (19-21). On the other hand, depression can be a risk factor for food insecurity through unemployment, lost productivity, increased health expenditure (22-24).

However, there is limited evidence on the association between food insecurity and depression among women in Ethiopia where the problem of food insecurity is rampant (13). In addition, the exiting literatures have limitations either in study size, representativeness and limitation in the use of locally validated tools (25, 26). In this study, we hypothesized that maternal depression is associated with food insecurity in highly food insecure setting and tested this using large representative sample and robust analytic method. Understanding women maternal depression is very important since studies have reported that maternal depression could be one of the pathway through which household food insecurity could impact child under nutrition(27-30).

Materials and Methods

Study setting

The study was conducted in Meskan and Mareko districts, in the Gurage Zone of the Southern Nations and Nationalities (SNNP) regional state. Butajira is the districts capital located at 135km south of Addis Ababa, capital city of Ethiopia and has an estimated population of 199,771.

The agro ecology of the district is characterized by an elevation ranging from approximately 1500 to 3,500 metres above sea level, with an average temperature ranging from 10-24^{o}C and an average annual rainfall ranging from 900 to 1,400 mm. The main means of livelihood in the district is a rain-fed agriculture, which is characterized by production of subsistence crops (primarily *Enset*, cereals, legumes, vegetables, fruits) and

some cash crops such as Khat (*Catha edulis*). Most of the households are affected by chronic food insecurity and are prone to drought.

Butajira Health and Demographic surveillance site (HDSS), which is located in Butajira, is one of the oldest surveillance sites in Africa established in 1986. It consists of nine rural and one urban kebeles (the smallest administrative unit in Ethiopia) from different ecological zones. Each kebeles has one or two permanent enumerators who are residents of the respective kebeles. Seven health centers, 40 health posts and two hospitals serves the residents in the district.

Study design and period

This study employed a cross sectional design. The data was collected between during the post harvest season i.e. December 2013 and April 2014.

Sample size and sampling

The analytical sample for this study was based on a sample size calculated for another objective that aimed to examine the spatial variations in the distribution of under nutrition in southern Ethiopia (31). The sample size available for the present analysis was 3091 women with children between the ages of 0-59 months. We recalculated the power of the analytic sample for its adequacy to answer the present research question. The power based on normal approximation with continuity correction was 98.8%.

The Health extension workers provided us with the list of houses, names of the household's head and the family profile. This was obtained from the family registry forms and used simple random sampling to select eligible houses that have one or more children under the age of five years.. We visited all houses with support from the HEWs, local guides and study supervisors.

Outcome measures

The main outcome of the study was maternal depression. Maternal depression was measured using the Patient Health Questionnaire-9 (PHQ-9)(32). The PHQ-9 is a self-report

168 measure used to screen major depressive disorders (MDD). The PHQ_9 has been found to
169 be valid in two studies from Ethiopia in different treatment settings: tertiary hospital
170 medical out-patients (33)and in primary care out-patients in the study area (34). The PHQ-
171 9 is composed of nine items asked with a recall period of two weeks. The items inquire how
172 often respondents have been bothered by depressive symptoms, with response categories
173 of 0 “not at all”, 1 “several days, 2 “More than half the days, and 3 “nearly every day”.

174 In this study, the internal consistency of the PHQ-9 was moderate (Cronbach’s alpha value
175 of 0.65). A validation work in another study has shown evidence of construct validity:
176 factor analysis indicated a uni-dimensional scale. Core depression items (feeling down,
177 little interest) were among the items most strongly related to the underlying construct
178 (33).
179

180 **Other measures**

181 The main explanatory (exposure) variable considered was the level of household food
182 insecurity. Secondary variables measured in the analytic sample were woman’s age, marital
183 status, religion, ethnicity, education, husband’s occupation, household’s head’s gender,
184 household’s wealth and dietary diversity. Socioeconomic status was measured using a
185 customized questionnaire asking about ownership and size of land, type of house and
186 construction materials, availability of radio, television, house telephone, mobile phone, bed,
187 chair , refrigerator, electric stove, clock/watch, electricity and possession of domestic
188 animals, and sanitation facility and source of water.

189 **Household food insecurity and dietary diversity**

190 We used The Household Food Insecurity Assessment scale (HFIAS) tool to measure the
191 magnitude of food Insecurity at household level (35). The HFIAS tool was validated and
192 has showed to perform well with minor adaptations in the same setting (36). The HFIAS is
193 a nine-item scale with self-reported items using a recall period of four weeks and response
194 categories relating to the frequency of occurrence.

We collected data on food groups eaten by the respective house during the day and night preceding the survey. A dietary diversity score for each house was generated using the sum of all food groups consumed. The total number of food groups consumed by households could range from 0 to 12. Based on the reported number of food groups consumed, we classified households into lowest, medium and high dietary diversity[37].

Data collection

We recruited twenty research assistants and two supervisors who had experience in data collection and supervision. We conducted a comprehensive training on the administration of the questionnaire and interviewing skills. One of the authors (S.H.G.) translated the questionnaire into the Amharic language (official language) by and reviewed together with the research assistants who were residents in the study district. We conducted a pre-test in a nearby district with socio-economic characteristics similar to those in the study district.

Data analysis

We used EpiData version 3·1 for data entry and Stata 13.0 (StataCorp, College Station, TX) for data cleaning and initial analysis. Data were cleaned for inconsistencies and missing values. All variables with missing data were reported. Descriptive analysis was done on explanatory variables using frequency distributions and summary statistics. We evaluated the comparability between the women in the food secure and food insecure groups using $x^2$and t test as appropriate. Maternal depression was indicated by categorization of total PHQ score as follows: 5-9 mild depression, 10-14 moderate depression, 15-19 moderately severe depression and greater than 20 severe depression.

We used the HFIAS tool to classify households into four levels of food insecurity: food secure, mildly food insecure, moderately food insecure and severely food insecure. The nine items in the HFIAS tool are ordered in such a way to reflect an increasing severity of food insecurity. A food secure household experiences none of the nine items in the HFIAS tool or only experienced the first item (worry about food) but rarely. A severely food insecure household experiences one of the last three items (7-9) (running out of food, going to bed hungry, or going a whole day and night without eating). The complete procedure

used to categorize a household to one of the four food insecurity levels is described elsewhere (31).

We used principal component analysis (PCA) to construct a household wealth index. The variables used in the PCA include ownership and size of land, type of house and construction materials, availability of fixed assets such as radio, television, phone, bed, and chair and other household items, possession of domestic animals, and type of water source for drinking and cooking, and availability and type of latrine. The resulting scores were divided into quintiles that indicate poorest, poor, medium, rich and richest.

A logistic regression model was fitted using Stata 11.0 (StataCorp, College Station, TX) to identify variables for Bayesian modeling. Explanatory variables such as the level of household food insecurity, maternal age, ethnicity, religion, husband's occupation, household wealth and gender of the household's head were statistically significant at 20% significance level (at P-value <0.2) and considered as potential explanatory variables for the Bayesian modeling.

Bayesian logistic regression model was undertaken using WinBUGS version 1.4.3 (MRC Biostatistics Unit, Cambridge and Imperial College London, UK)(see supplemental file) . We started with non-informative prior and 10000 iterations. We checked for convergence of parameters visually using history plot and kerenel density. Convergence was successfully achieved after 10,000 iterations. After convergence, a further 10,000 iterations were run and values were thinned by 10 and stored. The stored samples were used to calculate summary statistics (mean, SD, and 95% credible intervals) of the parameters.

Dose response analysis

We ran a dose response analysis in order to evaluate if the prevalence of depression increases with the increasing severity of household food insecurity. A test was performed using the Extended Mantel Haenszel Chi Square for linear trend using OpenEpi Software.

Results

Participant's characteristics

The analytic sample includes a total of 3091 mothers with one or more children under the age of five. Only fifteen (0.35%) households (i.e. mothers) were not included in this study because of unavailability after repeated visits.

The mean age of the mothers at the time of the interview was 33 years (SD=6.08). Most of the respondents were illiterate (74.4%) and housewives (69.7%). The great majority (94.0%) were married. Table 1 shows the differences in the background characteristics of the respondents who lived in food secure and food insecure households. Women who lived in the food insecure households were illiterate (x^2=37.8, p=<0.001), poor (x^2=62.2, p=<0.001) and had a lower dietary diversity score (x^2=30.3, p=<0.001) compared to women who lived in food secure households.

Magnitude of household food insecurity and maternal depression

The overall prevalence of food insecurity was 80.8% [95%CI: 79.4, 82.2]. Around 1,087 (35%) women lived in mild food insecure households, 1352 (43.7%) women lived in moderately food insecure households and 38 (1.2%) women lived in severely food insecure households.

The overall prevalence of depression (PHQ score of 5 and above) was 4.7 % [95% CI: 4.1, 5.6]. The overall prevalence of depression at the mild, moderate and severe threshold levels was 3.9% [95%CI: 3.3, 4.6], 0.9% [95%CI: 0.6, 1.2] and 0 %, respectively.

The overall mean PHQ-9 score was 1.27[95% CI: 1.20, 1.34, SD=1.87], ranging from 0 to 14 points. The mean PHQ-9 score was 1.48 [95%CI: 1.40, 1.56] in women who lived in food insecure households and 0.38[95% CI: 0.29, 0.48] in women who lived in food secure households (1.08 points lower [95%CI: -1.26, -0.93]).

The distribution of responses to the PHQ-9 items by household food security status is presented in Table 2. The responses to the problems were categorized into two; those without any problems (none) and those with the problems occurring in any frequency

(several days, more than half the day or nearly every day) over the past two weeks. PHQ item frequency ranged from 0.3% to 12% and 1.0% to 45.1% among women in the food secured and food insecure groups, respectively. "*Thoughts of being better off dead*" received the lowest affirmative responses in both groups of women.

All of the individual depressive symptoms had a significantly higher prevalence in the food insecure group, except for suicidal ideation (but small numbers) ($p<0.001$).For example, women in food in secured households, compared to the food secured group, reported seven times more on item 1: " *little interest or pleasure in doing things*" and eight times more on item 7: "*trouble concentering*"(table 2).

Household food insecurity and depression

In the Bayesian logistic regression model, women who live in food insecure households had higher odds of depression as compared to women who lived in food secure households (table 3). The model adjusted for mother's age, household wealth, husband's occupation, household head, religion, and ethnicity.

The adjusted odds ratio (AOR) for depression for differing levels of food insecurity was as follows: mild food insecurity AOR 3.29; 95% Bayesian credible interval [BCI]; 1.63–6.18, moderate AOR 3.82; 95% [BCI]; 1.91–7.45) and severe AOR 12.5; 95% [BCI]; 3.38–32.70). Other variables were also associated with depression: Female headed households (AOR 1.85; 95% [BCI]; 1.02, 3.01) and women who lived in the poorest households (1.85; 95% [BCI]; 1.00, 3.24) were more likely to be depressed. Women age was also associated with depression, those women who were older were more likely to be depressed than women who are younger (1.03; 95% [BCI]; 1.00, 1.06).

Dose response relation

The magnitude of depression increased as the level of household's food insecurity increased (Figure 1). We found a significant dose response linear relationship between

household food insecurity and women depression (dose response Extended Mantel-Haenszel chi square for linear trend= 20.54 and P<0.01)

Discussion

The present analysis employed a large cross sectional study to evaluate the association between household food insecurity and maternal depression. We used validated measures for both depression and food insecurity. After adjustment for a range of confounders, women who lived in food insecure households had significantly higher odds of depression compared to women who lived in food secure households.

The relationship between food insecurity and depression may be explained through different mechanisms. One of the mechanisms could be related to increased psychological stress associated with food insecurity. Household food insecurity is likely to be associated with worries about not having enough food for the family in general and for children in particular. Furthermore, shame because of eating a socially unacceptable diet may lead to stress. Due to these and other psychological stressors, women will be at higher risk of developing CMDs (19). Another possible mechanism that could explain why food insecure women are at higher risk of CMDs is related to nutritional deficiencies. There is an emerging evidence base indicating that specific nutrient deficiencies, such as folate, Vitamin D, Vitamin B12, Zinc, and omega-3, are associated with CMDs (20, 21).

The finding of higher odds of depression in women who lived in food insecure households is consistent with a number of previous studies (15-18, 26, 38, 39). Furthermore, the finding of this study is also in agreement with a systematic review of 11 qualitative and 16 quantitative studies conducted in low- and middle-income countries (LMICs) which confirmed a positive association between food insecurity and CMDs (19). We also found that the odds of depression increased as the level of household's food insecurity increased (39, 40).

Our analysis found that women who lived in the poorest households were more likely to be depressed than those who lived in the richest household. Although a similar finding is documented elsewhere, (23, 41, 42), the relationship between depression and poverty is complex (43). According to the social causation hypothesis, poverty raises the risk of mental illness through different pathways including increases stress, social segregation, violence, and trauma. On the other hand, according to the social selection hypothesis, people with mental illness are at increased risk of poverty through increased health expenditure, reduced productivity, stigma, and loss of employment and associated earnings. The social causation pathway might be more relevant to common mental disorders such as depression, whereas the social selection hypothesis might be more appropriate to disorders such as schizophrenia and intellectual disabilities (44).

The finding of this study should be interpreted with the context of the following limitations. Due to the cross sectional nature of the study, we cannot rule out the possibility of reverse causality, i.e. depression may cause household food insecurity..Secondly, this study did not take account for different determinants of depression including poor social support, recent stressful life events, previous depressive illness, violence, and physical illness which might not be evenly distributed among households of different levels of food insecurity. Moreover, respondent's bias with the anticipation of some form of support might overestimate the prevalence of food insecurity. Although this may not affect the association between depression and food insecurity as the anticipation of support might not differ between depressed and non-depressed women. In addition to these limitations, we admit that the present analysis is subjected to a recall bias. It has been documented that depressed women have negative cognitive distortion and may be more likely to give affirmative responses the household food insecurity questions.

The use of locally validated tools to measure depression (PHQ-9) and food insecurity (HFIAS) are important strengths of this study. In addition, we used large sample size with adequate power and this helped us to analyze the dose response trend among different levels of food insecurity and depression. Moreover, we applied a robust statistical analysis in a Bayesian framework which enabled us to get robust estimates.

In conclusion, household food insecurity was found to be an important determinant of women depression in rural Ethiopia. However, further research employing robust research designs are recommended to answer the relationship between food security and depression. For this, we recommend a prospective study design with a cohort of food secure and insecure households that are screened for depression at a baseline. Furthermore, we recommend a study that aim to evaluate the mechanism (s) to explain the relationship between food insecurity and depression. This might involve testing the hypothesis that some micronutrient deficiencies could explain the relationship between food insecurity and depression. In addition, intervention studies are required to test the weather interventions to reduce food insecurity lead to decreased maternal depression.

385 Table 1 Socio-demographic characteristics of women according to household food security
386 status in south central Ethiopia, 2014
387

Characteristics	Food secure	Food insecure	p-value
	(n, %)	(n, %)	
Mother's age (years)			
mean (SD	33.9(6.9)	33.7(6.4)	0.618
< 20years	5(0.9)	11(0.4)	0.031
20-34 years	274(46.4)	1198(47.9)	
35-49 years	282(47.7)	1219(48.8)	
>49 years	30(5.1)	72(2.9)	
Mother's education			
Illiterate	396(67.0)	1905(76.2)	<0.001
Able to read and write	45(7.6)	73(1.9)	
Primary school and above	143(24.2)	503(20.1)	
Marital Status			
Currently married	552(93.4)	2354(94.2)	0.484
Currently unmarried	39(6.6)	146(5.8)	
Maternal Occupation			
Housewife	374(63.3)	1781(71.2)	0.001
Farmer and housewife	49(8.3)	208(8.3)	
Merchant	135(22.8)	398(15.9)	
Other(daily laborer, student etc)	17(2.7)	48(1.9)	
Religion			
Orthodox Christian	161(27.2)	546(21.8)	<0.001
Muslim	363(61.4)	1781(71.2)	
Others(protestant, Catholic)	62(10.5)	159(6.4)	
Husband's Occupation			
Farmer	501(84.8)	2262(90.4)	<0.001
Daily laborer	11(1.9)	81(3.2)	
Employee/private/merchant	79(13.4)	158(6.3)	
Household head			
Female headed	48(8.1)	181(7.2)	<0.001
Male headed	529(89.5)	2303(92.1)	
Wealth quintile			
Poorest	105(17.7)	640(25.6)	<0.001
Poor	90(15.2)	476(19.0)	
Middle	97(16.4)	467(18.7)	
Rich	137(23.2)	548(21.9)	
Richest	162(27.4)	369(14.8)	
Ethnicity			
Guraghe	476(80.5)	1921(76.8)	0.015
Silte	65(11.0)	402(16.1)	
Mareko	28(4.7)	93(3.7)	
Others	22(3.7)	84(3.4)	

Dietary diversity				
	Mean (SD)	4.3(0.9)	4..1(0.8)	<0.001
	Lowest	79(13.4)	890(15.6)	<0.001
	Medium	451(76.3)	1994(79.8)	
	High	61(10.3)	116(4.6)	
Depression status				
	Mean (SD)	0.4 (1.15)	1.5(1.9)	<0.001
	Depressed	8(1.3)	139(5.6)	<0.01

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Table 2. PHQ-9 scale items responses of women living in food secure and food insecure households Ethiopia, 2014

Depressive symptoms (PHQ-9 scale Items)	Food secure women (N=591)		Food insecure women (N=2500)		p-value
	None (%)	Several days per week or more (%)	None (%)	Several days per week or more (%)	
Q1. Little interest or pleasure in doing things	97.6	2.4	85.3	14.7	<0.001
Q2. Feeling down, depressed, or hopeless	95.4	4.6	86.7	13.3	<0.001
Q3. Trouble falling or staying asleep	95.9	4.1	89.4	10.6	<0.001
Q4. Feeling tired or having little energy	88.0	12.0	54.9	45.1	<0.001
Q5. Poor appetite or overeating	96.1	3.9	87.7	12.3	<0.001
Q6. Feeling bad about self	98.6	1.4	94.6	5.4	0.001
Q7. Trouble concentrating	98.3	1.7	85.3	14.7	<0.001
Q8. Moving or speaking slowly	99.3	0.7	97.5	2.5	<0.05
Q9. Thoughts of being better off dead	99.7	0.3	99.0	1.0	0.297

Table 4. Bayesian logistic model for the relationship between food security and maternal depression, 2014.

Background characteristics	Depression			
	Bayesian logistic regression model			
	Posterior Mean	SD	Median	Adjusted 95% Bayesian credible intervals (BCI) OR (95% BCI)
Household Food security				
Food secure	-	-	-	1.0
Mild food insecure	3.29	1.2	3.1	**3.29[1.63,6.18]***
Moderately food insecure	3.82	1.4	3.6	**3.82[1.91,7.45]***
Severely food insecure	12.5	7.6	10.7	**12.5[3.38,32.7]***
Household head				
Male headed	-	-	-	1.0
Female headed	1.85	0.49	1.80	**1.85[1.02,3.01]***
Household wealth				
Richest	-	-	-	1.0
Rich	1.00	0.36	0.94	1.00[0.48,1.82]
Middle	1.35	0.47	1.28	1.35[0.69,2.47]
Poor	1.87	0.60	1.76	1.87[0.95,3.63]
Poorest	1.85	0.59	1.74	**1.85[1.00,3.24]***
Mother's age (years)*[a]	1.03	0.01	1.03	**1.03[1.00,1.06]***
Ethnicity				
Guraghe	-	-	-	1.0
Silte	0.98	0.24	0.96	0.98[0.57,1.53]
Mareko	1.15	0.52	1.06	1.15[0.41,2.45]
Others	1.97	0.78	1.85	1.97[0.82,3.81]
Husband's Occupation				
Farmer	2.45	1.54	2.03	2.45[0.87,6.70]
Daily laborer	1.79	1.59	1.36	1.79[0.29,5.72]
Employee/private/merchant	-	-	-	1.0
Religion				
Orthodox Christian	1.54	0.60	1.42	1.54[0.72,3.43]
Muslim	1.00	0.38	0.92	1.00[0.48,1.99]
Others	-	-	-	1.0

****Significant*[a]Maternal age is treated as a continuous variable***

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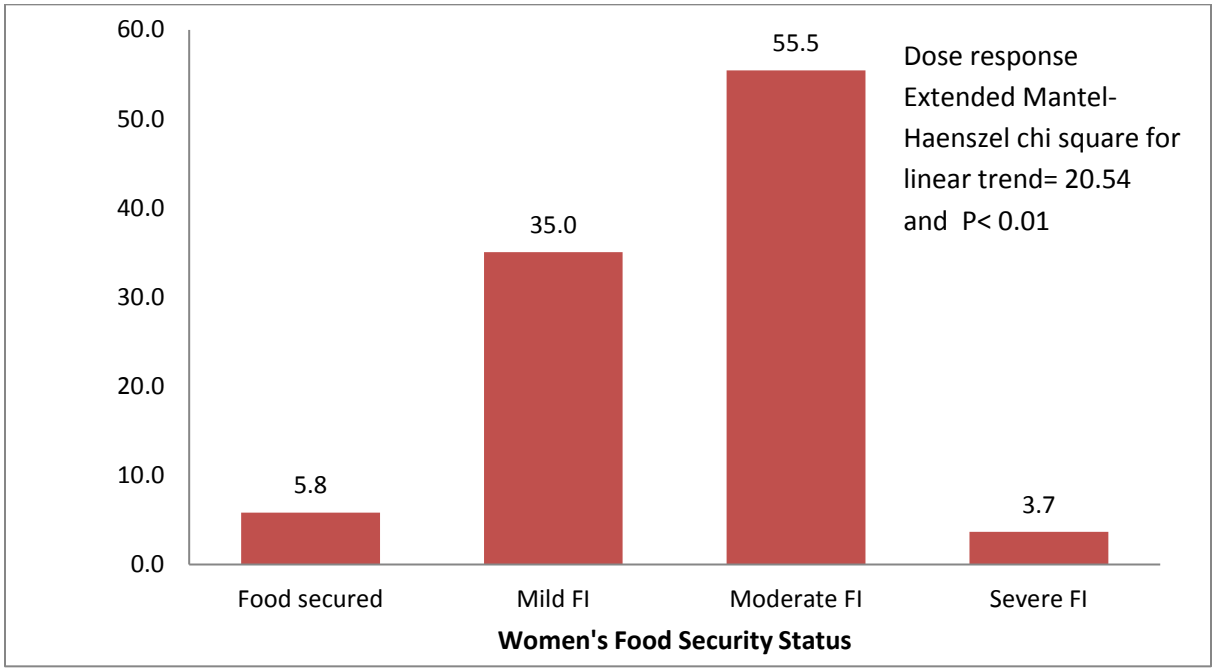

Figure 1. Percentage of women with depression by household food Security Status, South central Ethiopia, 2014

References

1. Vos T, Allen C, Arora M, Barber RM, Bhutta ZA, Brown A, et al. Global, regional, and national incidence, prevalence, and years lived with disability for 310 diseases and injuries, 1990–2015: a systematic analysis for the Global Burden of Disease Study 2015. The Lancet. 2016;388(10053):1545-602.
2. Fisher J, Mello MCd, Patel V, Rahman A, Tran T, Holton S, et al. Prevalence and determinants of common perinatal mental disorders in women in low-and lower-middle-income countries: a systematic review. Bulletin of the World Health Organization. 2012;90(2):139-49.
3. Harpham T, Huttly S, De Silva MJ, Abramsky T. Maternal mental health and child nutritional status in four developing countries. Journal of epidemiology and community health. 2005;59(12):1060-4.
4. Deyessa N, Berhane Y, Alem A, Ellsberg M, Emmelin M, Hogberg U, et al. Intimate partner violence and depression among women in rural Ethiopia: a cross-sectional study. Clinical practice and epidemiology in mental health. 2009;5(1):8.
5. Hanlon C, Medhin G, Alem A, Tesfaye F, Lakew Z, Worku B, et al. Impact of antenatal common mental disorders upon perinatal outcomes in Ethiopia: the P-MaMiE population-based cohort study. Tropical Medicine & International Health. 2009;14(2):156-66.
6. Bitew T, Hanlon C, Kebede E, Honikman S, Onah MN, Fekadu A. Antenatal depressive symptoms and utilisation of delivery and postnatal care: a prospective study in rural Ethiopia. BMC pregnancy and childbirth. 2017;17(1):206.
7. Dibaba Y, Fantahun M, Hindin MJ. The association of unwanted pregnancy and social support with depressive symptoms in pregnancy: evidence from rural Southwestern Ethiopia. BMC pregnancy and childbirth. 2013;13(1):135.
8. Hadley C, Tegegn A, Tessema F, Cowan JA, Asefa M, Galea S. Food insecurity, stressful life events and symptoms of anxiety and depression in east Africa: evidence from the Gilgel Gibe growth and development study. Journal of Epidemiology & Community Health. 2008;62(11):980-6.
9. Bitew T. Prevalence and risk factors of depression in Ethiopia: a review. Ethiopian journal of health sciences. 2014;24(2):161-9. Epub 2014/05/06.
10. Fekadu A, Medhin G, Selamu M, Hailemariam M, Alem A, Giorgis TW, et al. Population level mental distress in rural Ethiopia. BMC psychiatry. 2014;14(1):194.
11. Molla GL, Sebhat HM, Hussen ZN, Mekonen AB, Mersha WF, Yimer TM. Depression among Ethiopian adults: cross-sectional study. Psychiatry journal. 2016;2016.
12. FAO I. WFP (2015) The state of food insecurity in the world 2015—Meeting the 2015 international hunger targets: taking stock of uneven progress. FAO, Rome, 56p.
13. Endale W, Mengesha ZB, Atinafu A, Adane AA. Food Insecurity in Farta District, Northwest Ethiopia: a community based cross–sectional study. BMC research notes. 2014;7(1):130.
14. Headey D. An analysis of trends and determinants of child undernutrition in Ethiopia, 2000–2011. International Food Policy Research Institute (IFPRI). 2014.
15. Hadley C, Tegegn A, Tessema F, Cowan JA, Asefa M, Galea S. Food insecurity, stressful life events and symptoms of anxiety and depression in east Africa: evidence from the Gilgel Gibe growth and development study. Journal of epidemiology and community health. 2008;62(11):980-6.
16. Hadley C, Patil CL. Food insecurity in rural Tanzania is associated with maternal anxiety and depression. American Journal of Human Biology. 2006;18(3):359-68.
17. Noonan K, Corman H, Reichman NE. Effects of maternal depression on family food insecurity. Economics & Human Biology. 2016;22:201-15.
18. Huddleston-Casas C, Charnigo R, Simmons LA. Food insecurity and maternal depression in rural, low-income families: a longitudinal investigation. Public health nutrition. 2009;12(08):1133-40.

19. Weaver LJ, Hadley C. Moving beyond hunger and nutrition: a systematic review of the evidence linking food insecurity and mental health in developing countries. Ecology of Food and Nutrition. 2009;48(4):263-84.
20. Jacka FN, Maes M, Pasco JA, Williams LJ, Berk M. Nutrient intakes and the common mental disorders in women. Journal of affective disorders. 2012;141(1):79-85.
21. Rao TS, Asha M, Ramesh B, Rao KJ. Understanding nutrition, depression and mental illnesses. Indian journal of psychiatry. 2008;50(2):77.
22. Beck A, Crain AL, Solberg LI, Unützer J, Glasgow RE, Maciosek MV, et al. Severity of depression and magnitude of productivity loss. The Annals of Family Medicine. 2011;9(4):305-11.
23. Patel V, Kleinman A. Poverty and common mental disorders in developing countries. Bulletin of the World Health Organization. 2003;81(8):609-15.
24. Stewart WF, Ricci JA, Chee E, Hahn SR, Morganstein D. Cost of lost productive work time among US workers with depression. Jama. 2003;289(23):3135-44.
25. Maes KC, Hadley C, Tesfaye F, Shifferaw S. Food insecurity and mental health: surprising trends among community health volunteers in Addis Ababa, Ethiopia during the 2008 food crisis. Social science & medicine. 2010;70(9):1450-7.
26. Jebena MG, Taha M, Nakajima M, Lemieux A, Lemessa F, Hoffman R, et al. Household food insecurity and mental distress among pregnant women in Southwestern Ethiopia: a cross sectional study design. BMC pregnancy and childbirth. 2015;15(1):250.
27. Hadley C, Tessema F, Muluneh AT. Household food insecurity and caregiver distress: equal threats to child nutritional status? American Journal of Human Biology. 2012;24(2):149-57.
28. Jyoti DF, Frongillo EA, Jones SJ. Food insecurity affects school children's academic performance, weight gain, and social skills. The Journal of nutrition. 2005;135(12):2831-9.
29. Wemakor A, Mensah KA. Association between maternal depression and child stunting in Northern Ghana: a cross-sectional study. BMC public health. 2016;16(1):869.
30. Harpham T, Huttly S, De Silva MJ, Abramsky T. Maternal mental health and child nutritional status in four developing countries. Journal of Epidemiology & Community Health. 2005;59(12):1060-4.
31. Seid O, Tadesse K, Gebremedhin A. Iron deficiency anemia is moderate public health problem among school going adolescent girls in Berahle district, Afar, northeast Ethiopia. J Food Nutr Sci. 2015;3:10-6.
32. Kroenke K, Spitzer RL. The PHQ-9: a new depression diagnostic and severity measure. Psychiatric annals. 2002;32(9):509-15.
33. Gelaye B, Williams MA, Lemma S, Deyessa N, Bahretibeb Y, Shibre T, et al. Validity of the patient health questionnaire-9 for depression screening and diagnosis in East Africa. Psychiatry research. 2013;210(2):653-61.
34. Hanlon C, Medhin G, Selamu M, Breuer E, Worku B, Hailemariam M, et al. Validity of brief screening questionnaires to detect depression in primary care in Ethiopia. Journal of affective disorders. 2015;186:32-9.
35. Swindale A, Bilinsky P. Household food insecurity access scale (HFIAS) for measurement of household food access: indicator guide (v. 3). Washington, DC: Food and Nutrition Technical Assistance Project, Academy for Educational Development. 2007.
36. Gebreyesus SH, Lunde T, Mariam DH, Woldehanna T, Lindtjørn B. Is the adapted Household Food Insecurity Access Scale (HFIAS) developed internationally to measure food insecurity valid in urban and rural households of Ethiopia? BMC Nutrition. 2015;1(1):2.
37. Kennedy G, Ballard T, Dop MC. Guidelines for measuring household and individual dietary diversity: Food and Agriculture Organization of the United Nations; 2011.
38. Sorsdahl K, Slopen N, Siefert K, Seedat S, Stein DJ, Williams DR. Household food insufficiency and mental health in South Africa. Journal of epidemiology and community health. 2011;65(5):426-31.

39. Whitaker RC, Phillips SM, Orzol SM. Food insecurity and the risks of depression and anxiety in mothers and behavior problems in their preschool-aged children. Pediatrics. 2006;118(3):e859-e68.
40. Dewing S, Tomlinson M, le Roux IM, Chopra M, Tsai AC. Food insecurity and its association with co-occurring postnatal depression, hazardous drinking, and suicidality among women in peri-urban South Africa. Journal of affective disorders. 2013;150(2):460-5.
41. Brown GW, Moran PM. Single mothers, poverty and depression. Psychological medicine. 1997;27(01):21-33.
42. Martikainen P, Adda J, Ferrie J, Smith GD, Marmot M. Effects of income and wealth on GHQ depression and poor self rated health in white collar women and men in the Whitehall II study. Journal of epidemiology and community health. 2003;57(9):718-23.
43. Lund C, Breen A, Flisher AJ, Kakuma R, Corrigall J, Joska JA, et al. Poverty and common mental disorders in low and middle income countries: a systematic review. Social science & medicine. 2010;71(3):517-28.
44. Hudson CG. Socioeconomic Status and Mental Illness: Tests of the Social Causation and Selection Hypotheses. American Journal of Orthopsychiatry. 2005;75.

Supplemental Appendix

Maternal depression symptoms are highly prevalent among Food insecure households of Ethiopia

Binary logistic model structure and description

The binary logistic models were of the form:

$$Y_{ij} \sim bernoulli\,(p_{ij}),$$

$$logit\,(p_{ij}) = \alpha + \sum_{i=1}^{p} \beta_i \times \chi_i + \sum_{j=1}^{p} \beta_j \times \chi_{i,j} + v_i$$

Where Y_{ij} is the status of depression (depressed or not) of a mother *i* in a village *j*, p_{ij} is the probability of a mother *i* in a village *j* being depressed or not , α is the intercept, $\sum_{i=1}^{p} \beta_i \times \chi_i$ is a vector of explanatory variables multiplied by their coefficients β_i, $\sum_{j=1}^{p} \beta_j \times \chi_{i,j}$ is a vector of explanatory variables at village level multiplied by their coefficients β_j, v_i is the error term (random effect)

We specified the model with non-informative prior for the intercept and the coefficients (mean equal to 0 and precision of $1x\ 10^6$). Three chains of models with an initial of 10000 iterations were run. The values of the coefficient and intercept were stored and evaluated for convergence using diagnostic tests. We checked for convergence of parameters visually using history plot and kerenel density. Convergence was successfully achieved after 10,000 iterations. After convergence, a further 10,000 iterations were run and values were thinned by 10 and stored. The stored samples were used to calculate summary statistics (mean, SD, and 95% credible intervals) of the parameters.

Table 1. shows results from a Bayesian logistic model and classic regression for the relationship between food security and maternal depression, 2014.

Background characteristics	**Depression**	
	Logistic regression (rare events)	**Bayesian logistic regression model**
	Adjusted 95% CI	**Adjusted 95% Bayesian credible intervals (BCI) OR (95% BCI)**
Household Food security		
Food secure	1.0	1.0
Mild food insecure	**3.88[1.63,9.23]***	**3.29[1.63,6.18]***
Moderately food insecure	**4.32[1.84,10.15]***	**3.82[1.91,7.45]***
Severely food insecure	**16.53[4.87,56.1]***	**12.5[3.38,32.7]***
Household head		
Male headed	1.0	1.0
Female headed	1.44[0.64,3.22]	**1.85[1.02,3.01]***
Household wealth		
Richest	1.0	1.0
Rich	1.21[0.62,2.41]	1.00[0.48,1.82]
Middle	1.57[0.79,3.14]	1.35[0.69,2.47]
Poor	**2.06[1.05,4.05]***	1.87[0.95,3.63]
Poorest	**2.08[1.09,3.96]***	**1.85[1.00,3.24]***
Mother's age (years)*[a]	1.03[0.9,1.06]	**1.03[1.00,1.06]***
Ethnicity		
Guraghe	1.0	1.0
Silte	0.95[0.35,2.57]	0.98[0.57,1.53]
Mareko	1.02[0.61,1.73]	1.15[0.41,2.45]
Others	1.97[0.87,4.46]	1.97[0.82,3.81]
Husband's Occupation		
Farmer	1.62[0.67,3.97]	2.45[0.87,6.70]
Daily laborer	1.28[0.35,4.70]	1.79[0.29,5.72]
Employee/private/merchant	1.0	1.0
Religion		
Orthodox Christian	**1.68[1.07,2.55]***	1.54[0.72,3.43]

Muslim	1.51[0.72,3.15]	1.00[0.48,1.99]
Others	1.0	1.0